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Proceedings of the 2009 Recovery Potential Assessment (RPA) for Atlantic Whitefish (*Coregonus huntsmani*)

24-25 March 2009
Days Inn,
Dartmouth, NS

Tana Worcester
Meeting Chairperson

Compte rendu de l'évaluation du potentiel de rétablissement du corégone atlantique (*Coregonus huntsmani*) de 2009

Les 24 et 25 mars 2009
Hôtel Days Inn
Dartmouth (Nouvelle-Écosse)

Tana Worcester
Présidente de la réunion

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June 2010 | **Juin 2010**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made at the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

This workshop was not carried out as a formal Fisheries and Oceans Canada (DFO) Science Advisory process; however, it is being documented in the Canadian Science Advisory Secretariat's (CSAS) Proceedings series as it presents some topics of interest related to the advisory process.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

Le présent atelier n'a pas été tenu dans le cadre officiel du processus des avis scientifiques du ministère des Pêches et des Océans (MPO). Celui-ci est toutefois documenté dans la série des comptes rendus du Secrétariat canadien de consultation scientifique (SCCS), car il couvre certains sujets en lien avec le processus des avis.

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SUMMARY

A Maritimes Science Advisory Process to assess the recovery potential of Atlantic whitefish was held on 24-25 March 2009 at the Days Inn in Dartmouth, Nova Scotia. Participants included DFO Science, Habitat Management, Resource Management and Species at Risk Office, recovery team members, and the Province of Nova Scotia. This meeting was intended to help consolidate new information on Atlantic whitefish in preparation for reassessment by the Committee on the Status of Endangered Wildlife Species in Canada. The results of the Recovery Potential Assessment are intended to support decisions on permitting of incidental harm, and to support ongoing recovery planning efforts as described in the current Recovery Strategy.

SOMMAIRE

Un processus de consultation scientifique des Maritimes visant à évaluer le potentiel de rétablissement du corégone atlantique a été suivi les 24 et 25 mars 2009 à l'hôtel Days Inn de Dartmouth, en Nouvelle-Écosse. On comptait parmi les participants des représentants du Secteur des sciences, de Gestion de l'habitat, de Gestion des ressources et du Bureau des espèces menacées de disparition du MPO, de l'équipe de rétablissement et de la province de la Nouvelle-Écosse. La réunion avait pour objectif d'aider à regrouper les nouvelles informations à propos du corégone atlantique, en vue d'une réévaluation par le Comité sur la situation des espèces en péril au Canada. Les résultats de l'évaluation du potentiel de rétablissement serviront à appuyer les décisions sur l'octroi de permis pour dommages fortuits et les efforts continus de planification en matière de rétablissement, tels que décrits dans la stratégie de rétablissement actuelle.

INTRODUCTION

The Chair of the meeting, T. Worcester, welcomed everyone and thanked them for coming in bad weather to this DFO Science Advisory Process to assess the recovery potential for Atlantic whitefish. Participants introduced themselves (Appendix 1), and they were all encouraged to participate actively in the discussion.

This is not the first time that DFO Science has conducted an assessment of Atlantic whitefish. The last assessment was conducted in November 2004 as an Allowable Harm Assessment. Since this time, DFO has developed a more extensive Terms of Reference for assessing species at risk. Given the data poor nature of Atlantic whitefish, it is not expected that this meeting will be able to address all of the Terms of Reference in detail, but efforts will be made to describe the current state of knowledge on each of them. The purpose of the meeting is to update new research and information obtained since the last assessment in 2004 and to address, to the extent possible, the Terms of Reference of the Recovery Potential Assessment, which is expected to support the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) re-evaluation, incidental harm permitting and recovery planning.

Atlantic whitefish, a species endemic to Nova Scotia, was designated as endangered by COSEWIC in 1984. It was reassessed by COSEWIC in 2000, at which time its endangered status was re-confirmed. Atlantic whitefish has been listed (thus protected) on Schedule 1 of the *Species at Risk Act* (SARA) since its enactment in 2004. A recovery strategy for this species was published in 2007. Atlantic Whitefish will be up for reassessment by COSEWIC in 2010.

The specific Terms of Reference for the meeting (Appendix 2) and the Agenda (Appendix 3) were reviewed. Nothing further was added.

Background information was provided prior to the meeting in the form of two working papers. Links were also provided to the research documents and proceedings of the 2004 assessment. It was noted that the two working papers would be published as Research Documents if accepted by the meeting. The discussion of the meeting was captured in this proceedings. A draft Science Advisory Report provided for the consideration of the meeting participants, which was subsequently modified to capture the advice of the meeting on each of the Terms of Reference. The final Science Advisory Report is available on the Canadian Science Advisory Secretariat website (DFO, 2009).

ASSESSMENT OF ATLANTIC WHITEFISH

Working Paper: Bradford, R.G. P. Bentzen, D.M. Campbell, A.M. Cook, A.J.F. Gibson, and J. Whitelaw. 2009. Update Status Report for Atlantic Whitefish (*Coregonus huntsmani*). CSA Working Paper 2009/15.

Presentation: Introduction and Methodology
Presenter: R. Bradford
Rapporteurs: S. O'Neil and T. Worcester

Presentation Highlights

Atlantic whitefish were first described by Hunstman in 1922. They were found in two river systems (i.e., the Tusket-Annis and Petite Rivière watersheds in southwestern Nova Scotia). Threats identified by COSEWIC include: habitat loss and degradation caused by acidification,

hydroelectric dams, introductions of exotic species, and incidental fishing. Atlantic whitefish have been protected under SARA since 2004. A recovery strategy has been completed.

A summary of a survey from 1926 of the number and location of dams within southwestern Nova Scotia rivers was presented. A survey from this period was considered to be useful as 1926 corresponds closely with the time when Atlantic whitefish were first described and recognized as rare. While information on their historical distribution is limited, the demographics of their known distribution implies they were likely more widespread in the past. Historical dam information may, therefore, provide context to the present status of Atlantic whitefish relative to an earlier time of probable pronounced decline. It is expected to help address the question of whether Atlantic whitefish would have existed elsewhere if not for dams/barriers. This information may also be useful to help identify candidate rivers for expansion of Atlantic whitefish distribution.

There is no index of Atlantic whitefish abundance with time. A variety of sampling methods, many in common use to monitor/sample lake dwelling coregonid species elsewhere in North America, have been used. Not all have been successful in capturing Atlantic whitefish. Gillnets can not be used except in extraordinary circumstances because they result in high mortality. Beach seines require a beach, but few beaches are present in the lakes where Atlantic whitefish occur. Efforts to collect young have generally failed. Efforts to collect Atlantic whitefish below the Milipsigate dam have generally been successful.

When Atlantic whitefish arrive in May/June below Milipsigate Dam, they arrive in some numbers. They are often present with a rich fish assemblage. They are likely feeding on drift through the dam. Atlantic whitefish are up in the water column relative to other species. This timing coincides with the spawning run for white sucker, so Atlantic whitefish may be feeding on the white sucker spawn. Young Atlantic whitefish have not been seen in this mix. It is still a mystery where the young are and what their preferred habitat may be.

The lakes where Atlantic whitefish occur are approximately 16 km^2 in area but are quite shallow. A rigid floating trap-net frame has recently been developed to sample within the lake, with some success although the catches are generally small (e.g., 0-5 fish per day). Much of the information that has been collected of Atlantic whitefish has been from fish bred and reared in captivity at the Mersey Biodiversity Facility. No new systematic surveys of Nova Scotia river drainages have been conducted since 2004, but some observations concerning Atlantic whitefish occurrences have been made. It would be useful to go into Minamkeak Lake to determine whether Atlantic whitefish are still there (last surveyed in 2004) after several years of smallmouth bass presence. Young smallmouth bass are now being found in Milipsigate Lake.

Discussion

There was some discussion of additional studies that have been conducted on Atlantic whitefish but that were not presented here. For example, some Atlantic whitefish with acoustic tags had been released recently into the lower Petite Rivière and tracked with hydrophones. The fish were followed for a period of time and some acoustic transmissions were detected. Some useful information was gained, but this work is only preliminary. Fish introduced about mid-river into the Petite Rivière system below Crousetown dam, when given a choice of going upriver or down, went up river, for example. To date there is no obvious pattern in where they went in general; however, one was detected halfway up the Medway River. Some returned in spring or fall. It was hoped that some means of monitoring their movement up the river would be in place by now, but that hasn't been implemented yet. It was suggested that a paragraph was required in the Research Document on these releases and preliminary results. It was noted that the fish

released were captive reared, but the results may be useful within the context of habitat characteristics. Additional results will be provided in the future.

Presentation: Phylogenetic Status and Intraspecific Genetic Diversity
Presenter: P. Bentzen
Rapporteurs: S. O'Neil and T. Worcester

Presentation Highlights

The methodology and results of the genetic analysis were presented. Results indicate that Atlantic whitefish have not hybridized with lake whitefish, and they remain genetically distinct from other species. Results also suggest that Atlantic whitefish is an early primitive offshoot of coregonids. An investigation of genetic diversity relative to lake size (allele richness versus size) indicated a significant relationship for other species, but not for Atlantic whitefish. Lack of allelic richness suggests that Atlantic whitefish have been through (or are currently going through) a population bottleneck.

Discussion

It was asked whether a baseline was required if one is trying to look at richness, and also whether there was comfort with the level of richness that was found. It was noted that the same microsatelittes were looked at in each of the three species, and there was a consistent pattern of lower diversity in each of the loci. There is no tendency for Atlantic whitefish alleles to be smaller than the other species -- they are sometimes bigger. They are not just changing slower because they are small.

If you know the mutation rate, you can estimate the long-term population size, assuming that the long-term mutation rate is similar (relative to other species). Long-term effective population size tends to be lower than current population size, since it reflects population bottlenecks of a couple hundred Atlantic whitefish. Alternatively, it could be a function of low population size now. The current abundance is not known. However, it is expected that there are more than a few hundred Atlantic whitefish now.

It was noted that no genetic samples were available from the (historical) run of anadromous Atlantic whitefish on the Tusket River.

It was clarified that the genetic analyses reflects both historical and current connectivity. It was noted that Minemkeak Lake was diverted into Millipsigate Lake at some earlier date. Atlantic whitefish likely colonized Minemkeak Lake at that time.

It was asked whether the genetic analyses indicated that Atlantic whitefish are more migratory than lake whitefish. It did not necessary indicate this. The species are only found within three closely connected lakes. A similar pattern might be seen for lake whitefish under the same conditions.

Presentation: Life-History Characteristics
Presenter: R. Bradford
Rapporteurs: S. O'Neil and T. Worcester

Presentation Highlights

Atlantic whitefish are smaller at age in the wild than those that are captive bred. Juveniles have only been caught at Hebb Lake. There had been some discussion of marking them in the spring and recapturing them in the fall. By age 3, they are smaller at age. Fish under culture have a higher maximum theoretical length. For fish in the wild, the maximum length is 300 mm. The growth season is May 1 to October 30th. Growth curves are generated in May.

Atlantic whitefish are probably producing about 2,500 eggs per female in the wild, but this could be higher. Investment in individuals is high compared to other whitefish. A fish with a similar body size and life-history characteristics (pollan – found in Irish lakes), have an egg production estimate of 10,000 eggs per female, i.e., they produce more, but smaller eggs than Atlantic whitefish.

Discussion

A number of questions of clarification were asked about the growth curves, including whether the graphs were stacked or overlaid (they were stacked), and whether there were enough samples to separate wild from F1s given that the F1s tended to fall below the growth curve.

There was some discussion on why captive bred fish would have fewer eggs. Differing rearing environments (wild versus captive) was discussed as a possible contributing factor.

In the presentation of the ageing methodology, it was mentioned that scales were read independently by two readers. When the question was asked as to whether the two readers had to agree on criteria first, it was clarified that they had not but they had compared ageing results. As there is no ageing reference material for Atlantic whitefish, interpretations by different readers may be different. An alternate interpretation of the "annual" rings is that summer growth is followed by winter growth (i.e., two rings per year). If you decrease the ages of wild fish by one year, the growth differences between wild and captive fish may not be as strong, which would influence the conclusions. This would indicate that recovery of Atlantic whitefish might not be limited by growth and size at age but by higher mortality. This could potentially present a more positive outlook for the species as this would suggest there is greater potential for the population to rebuild. Ageing should, therefore, be included as a source of uncertainty. It was noted, however, that there are clear differences between wild and cultured fish, though it was uncertain whether this was due to differences in age or growth. Suggestions included: asking other agers for their interpretation, sending some samples to agers from other countries, using the captive fish of known ages as a reference (recognizing different rearing environments). It was agreed that the growth curves would remain as they were in the working paper, but additional analysis would be provided within the text of the Research Document. This still only addresses the issue of wild versus captive fish. It does not resolve the issue of current Atlantic whitefish fitness compared to past fitness.

It was noted that there was nothing in the working paper that discussed the potential for a population bottleneck based on Figure 6 (log lake area versus effective population size) in the working paper. It was noted that this figure compares Atlantic whitefish to populations that may be healthy with abundances closer to the carrying capacity. Atlantic whitefish may be an outlier because the abundance is quite low. There is also an assumption that lake whitefish and

Atlantic whitefish are ecologically similar, which is not expected to be the case. It is expected that Atlantic whitefish are more similar ecologically to cisco, and cisco does appear to have a similar relationship between log lake area and effective population size/genetic diversity compared with lake whitefish. This graph just shows that Atlantic whitefish appear to have a low abundance for the size of the lake that they're in. It was recognized that log lake area is a very crude measure of habitat size, but that it is one of the few available for use with Atlantic whitefish presently. It was asked whether the estimate of habitat area could be refined to better reflect more critically limiting factors.

It was noted that this approach could be used to estimate total mortality if maximum age is known. This analysis was not presented at the meeting, but it was suggested that these calculations could be provided in the Research Document. It was suggested that total mortality (Z) and natural mortality (M) could be assumed to be similar since there are no activities there are known to be causing direct mortality of fish. However, it was also noted that sampling is showing smaller, younger fish than historically, which could be an indication that natural mortality is higher (i.e., not seeing larger fish in the lake). No evidence was presented that suggested natural mortality had increased. While gillnet surveys using multipanels show an absence of fish in the larger panels, this does not mean that only younger fish are found in the lakes. It was expected that any difference in size between historical and current periods would be a result of the loss of anadromy. It is possible that something is preventing the landlocked fish from growing any larger. For example, the current demands for reproduction may be high. It was agreed that the loss of anadromy was a better explanation than a change in natural mortality. In addition, tagged fish that were released and recaptured in the Medway were believed to have grown (no measurements were taken). It was believed that there was a growth advantage to being in seawater. Possible explanations included: better food availability in the estuary or marine environment, and increased competition in the lakes. The limited stomach content analysis conducted to date (Edge, 1984) indicate that Atlantic whitefish are generalists, including small fish and eggs.

Presentation: Dams
Presenter: R. Bradford
Rapporteurs: S. O'Neil and T. Worcester

Presentation Highlights

A summary of a survey from 1926 of the number and location of dams within southwestern Nova Scotia rivers was presented. This survey specifically excluded small streams. Many rivers were blocked close to the head of tide (within 1 km). This suggests that access to rivers was being impeded very early on, prior to requirements for fish passage. However, access to the lower 15 km of the Tusket River was not impeded at that time: the dams were constructed on smaller branches. It is, therefore, of potential significance that this river supported the last known anadromous runs of Atlantic whitefish. The Petite had been blocked at the head of tide since 1808. Lack of fish passage was a constant complaint of fishers. Atlantic whitefish may have become landlocked in this system before 1950, but they continued to survive. The Petite is one of the few rivers that has not been severely impacted by acid rain.

Discussion

It was suggested that evidence of dams being breached would be interesting to investigate. It would be important to clarify whether they have been landlocked since earlier days or whether breaches have enabled their recolonization. It was noted that some Atlantic whitefish fall over the dam, but they have not been found to colonize other systems, or the portion of the Petite

Rivière below Hebbville Dam. There are Atlantic whitefish in the estuary, but it doesn't appear that there is a spawning run there. Atlantic whitefish had not been observed in the estuary in the fall.

There are no reports of Atlantic whitefish at other DFO monitoring facilities.

It was asked whether Atlantic whitefish could be migrating at night when no one is looking. It has been suggested that a fish sampling program at Crousetown could help to address this uncertainty.

It was suggested that a statement about Anderson Lake be included in the working paper and Science Advisory Report. There has not yet been any evidence of reproduction in Anderson Lake, but this needs to be looked at again in a year. It was noted that upon termination of this experiment (expected 2011-2012) a technical report will be prepared, and as well that annual updates on the project are available in the recovery team meeting minutes.

Working Paper: Cook, A.M., R.G. Bradford, B. Hubley, and P. Bentzen. 2009. Effects of pH, Temperature and Salinity on Age 0+ Atlantic Whitefish (*Coregonus huntsmani*). CSA Working Paper 2009/14.

Presentation: Environmental Effects on Atlantic Whitefish
Presenter: R. Bradford (for A. Cook)
Rapporteurs: S. O'Neil and T. Worcester

Presentation Highlights

It was noted that this work was conducted as part of Adam Cook's Ph.D. thesis at Dalhousie University. The study investigated what advantage Atlantic whitefish might have in being anadromous and whether the extant population that is presently restricted to freshwater continues to possess the physiological attributes that would enable anadromy. The focus of the work was on young (eggs, larvae, juvenile) stages of Atlantic whitefish, and it was conducted in the Aquatron at Dalhousie. Atlantic whitefish are anadromous by nature. They were known to migrate from seawater to freshwater in October-November on the Tusket River prior to extirpation. There is no information available on the freshwater to seawater migrations. Both temperature and pH are important environmental factors that affect fish. For example, Southern uplands Nova Scotia rivers have intrinsically low pH, which is further depressed by acid rain.

In this study, eggs were used to assess pH tolerance; larvae to assess pH and salinity; and early larvae to juveniles to assess pH, salinity and temperature. It was found that the older Atlantic whitefish get, the less sensitive they are pH. There is high survival of larvae in seawater. When acclimated first to 0, 15 and 30 ppt, then given 24 hours to find their preferred salinity, most preferred saltwater.

In a comparison of thermal physiology with other salmonids, Atlantic whitefish tolerance was below that for Atlantic salmon but above that for arctic char and sockeye salmon. Their maximum temperature tolerance is similar to Atlantic salmon, and their optimum temperature is similar (approximately 16 ^{0}C) to the temperature above which handling stress is observed with fish in the wild.

In tests of pH and temperature interactions under freshwater scenarios, it was observed that growth rates declined and optimum temperature increased with decreasing pH, but not significantly. Monthly pH means of various categories of rivers in the probable historical range of

Atlantic whitefish were determined, and a study was conducted to investigate how survival might be affected in each of the river categories. It was determined that survival is possible in all river categories, but it is higher in category 3 and 4 rivers (pH of 5.1 or greater). Survival was increased by anadromy at the lowest pHs.

The results of this study suggest that reintroduction of Atlantic whitefish to anadromous conditions would likely be tolerated and may offer some survival and recovery advantages to this species. Reintroductions to the Tusket would help to restore the species to its historic distribution. Reintroductions to other rivers could also be evaluated on the basis of these results coupled with the Decision Support Tool that had been under development since 2004.

Discussion

It was suggested that a better explanation of thermal tolerance was required in the working paper, as were the lower confidence intervals in the figures (only seemed to have upper confidence levels). It was also suggested that some of the data should be included in tables in this report. While the work was being prepared for primary publication, the Research Document was considered a good place to include any particularly useful data for future reference.

It was asked what the simulations were based on and what was being sampled. It seemed that only the pHs were being sampled.

It was noted that this work assumed that larvae can move, so it would be important to clarify whether this was true in the wild. It was suggested that it would be interesting to operate a smolt wheel on the system. There is an initiation of a downstream run of larvae in Finland (European whitefish – similar to our lake whitefish).

It was asked whether this work might indicate how far up the river Atlantic whitefish would go to spawn. While there are reports of Atlantic whitefish ascending the (Tusket) river, it was not clear how far up. The study results do not provide an answer to this question.

A question was asked about freshwater survival. It appears that Atlantic whitefish would be able to survive better in Category 3 and 4 Lakes like Petite and Mushamush (Medway, Carlton).

It was suggested that invasive species be taken into account in the evaluation of likelihood of survival. If invasive species are a major threat to Atlantic whitefish, then this work suggests that more acidified rivers could be considered for reintroduction. However, anadromy might also assist survival in the presence of an invasive species. For example, if a river was populated by smallmouth bass, the chance of survival of Atlantic whitefish might be higher if they were able to leave the river at an early age and could survive. The number of rivers in southwestern Nova Scotia that don't have smallmouth bass is pretty small.

There are two issues to be addressed: survival and recovery.

It was felt that more background information, e.g., on methods and how the model was fit, was needed to assess the working paper and the quality of the work. However, it was expected that additional information would demonstrate that the work had been done well. It was suggested that equation 2 should be checked. Clarification was sought on the life-history based survival curve, as it was not clear what was meant by that term. Within the simulation, there should be a table that shows what the distributions were.

It was noted that when you're comparing survival of different strategies, there needs to be a common end point. The end points here seem to be different -- survival of the larval phase through freshwater versus survival to sea. It was suggested that the comparisons weren't required just to describe habitat characteristics but might be needed for recovery purposes. The intent is to maintain the species in a condition similar to what it used to be. Since it used to be anadromous, recovery should also strive for this. Atlantic whitefish clearly still has the capability to be anadromous; however, they are also able to maintain themselves in freshwater.

Other habitat characteristics that could be explored include: oxygen, summer temperature, lake size, and water depth. It was clarified that summer maximum temperature appears to be limiting. There is no intention of lowering the water levels in the Petite lakes (for public safety reasons) on a long-term scale. The only possibility may be during a major storm event but this would not be a long-term event. The long-term goal would be raising the dam.

It was asked whether any lessons had been learned from Anderson Lake. It was suggested that it was too early to tell, as the metric would be their ability to reproduce. So far, the Atlantic whitefish in Anderson Lake tended to be found away from the shoreline.

It was suggested that the pH curve might under-predict the survival of eggs over a pH of 4.5 and over-predict the sensitivity of eggs below a pH of 4.3. It would be useful to add a qualifier to be careful in lakes around a pH of 4.3-4.5. The survival of Atlantic whitefish at these levels might be slightly higher than expected.

Clarification was sought on the definition of residence. There is no indication that Atlantic whitefish build nests/redds. The indication, via analogy to the general spawning of other coregonid species, is that they are broadcast spawners over rocky shoals.

There was some discussion about the identification of critical habitat for Atlantic whitefish. It was suggested that the three lakes currently containing Atlantic whitefish should be identified as critical habitat since the species are globally endemic to those three lakes. However, it was felt that it would be important to describe how this habitat is being used. There is not currently enough information to allocate individual parcels of critical habitat within the lakes, i.e., to say which parts they do or do not use. Some felt that all of the habitat in the lakes was required to fulfill all life-history requirements, and it would be hard to go to a smaller spatial scale than the entire lake. Human activities within the lakes are going to be limited anyway given that they are managed as a municipal water supply. There is no intention to use the lakes for another purpose. It was suggested that the best way to control land use is to own it. Efforts are being made to purchase as much of it as possible. Efforts are also being made to use the Wilderness Areas Protection Act to identify these lakes as recognized Wilderness Areas. The NS Department of Natural Resources wouldn't allow suspension of claims for mining otherwise. Identifying this as a Wilderness Area would help to restrict potential mining activity.

It was asked whether introduction of Atlantic whitefish into the Tusket River remains as a research recommendation. If so, it was suggested that a few more details be provided to support this recommendation. One of the characteristics of the Tusket is that it has a protected coastline. Also, it has existing infrastructure to support experiments. Mushamush is also on the list. It was noted that if the freshwater residence time of Atlantic whitefish having free access to tidal waters is very small, then smallmouth bass and chain pickerel might not be as big an issue.

Recovery Targets

The current goal of the Atlantic Whitefish recovery strategy is "to achieve stability in the current population of Atlantic whitefish in Nova Scotia, re-establishment of the anadromous form, and expansion beyond its current range" (DFO 2004). The discussion that followed was to determine a more specific recovery target for inclusion in the Recovery Potential Assessment.

It was agreed that a recovery target should be realistic and achievable within some period of time. It would be nice to be able to show some progress. The idea of an interim target was also supported. However, it was equally important to have the larger objective stated. One suggestion was that the target should be every feasible river between the two river systems known to have contained Atlantic whitefish. However, with only limited information about their past distribution, another suggestion was that any watershed within Nova Scotia could be considered as a candidate for Atlantic whitefish introduction, particularly the watersheds within their known former range. A third suggestion was to recommend a minimum of three populations, with the intent of trying for more. A fourth suggestion was to have an interim objective of maintaining the existing population; however, it was felt that not knowing the current abundance of Atlantic whitefish would be problematic.

There is some uncertainty about the number of populations that occurred in the past, but there were at least two (Tusket and Petite). More populations are better in terms of maintaining greater genetic variability. So far, only neutral DNA from samples within the Petite system have been investigated. It is suspected that a greater number of populations of Atlantic whitefish existed in the past. It was noted that Atlantic whitefish introduced to Anderson Lake are not yet considered a population until successful reproduction is confirmed.

Discussion ensued on the criteria that could be used to identify rivers and lakes that would support introductions of Atlantic whitefish including fish passage, absence of and/or scope for interaction with invasive species (i.e., smallmouth bass and chain pickerel), and pH. It was also suggested that the DST could be used to look at other areas. Whether the size of the watershed would be an important criterion for watershed selection for introduction was also discussed. It was felt that watershed size or some other proxy for habitat should be considered.

It is very clear that historical impediments to fish passage between tidal and non-tidal waters were extensive. Many fish species were maintained by stocking. Atlantic salmon is not a good indicator of persistence. Alewife may be a better indicator of historical presence. Alewife are still seen right to the foot of Hebb Lake. It might be reasonable to assume that Atlantic whitefish would share similar habitat space as alewife given their similar habitat preferences. They are not present in the Annapolis River and it hasn't been dammed. Some information on the passage requirements of other whitefish species is available from Scandinavia and Europe, but not all of it is relevant. Cisco might be another possible surrogate for Atlantic whitefish. It is likely that Atlantic whitefish would use a fish way. It was asked whether waterfalls (high gradient streams) would be as limiting to fish passage as dams. It was noted that there are some difference between these two things. There is a place that's fairly steep above Crousetown that anadromous fishes get beyond.

It was asked why there are not any Atlantic whitefish in Fancy Lake. There are in fact occassional reports of Atlantic whitfish occurrences in Fancys Lake, but these fish are thought to be strays from the upper lakes. Sampling with rod and reel and gill net sets of short duration (~1 hour) during the spring-summer periods of 2000 and 2001 did not yield any Atlantic whitefish. The lake is now full of smallmouth bass and has more development, so there is a

question of whether or not the lake may have supported Atlantic whitefish at one time but no longer.

There was some discussion about the capacity for establishing new populations using individuals from the existing population. It was suggested that returns from an anadromous run could be used for future experiments. It was noted that there were very few adults left in captivity to use for experimentation.

Discussion ensued on the development of numeric abundance target for the existing population within the three lakes. It was suggested that this could be related to the minimum viable population size, understanding that there are caveats on what is meant by viable. A proposed approach to defining Recovery Targets based on effective population size from the literature was presented. Some numbers that were discussed included 500 individuals and 1000 individuals (estimated for the Petite). It was noted that there are a few hundred fish observed in Hebb Lake, which is one third of the area. It was asked whether the minimum population target would be the same in a new area as in the existing area (i.e., would a target be 1000 individuals within a new lake?). It was proposed that recovery targets be presented as guidance (course approximation) rather than as firm numbers, and current impediments to fish passage should be described. It should also be clearly stated that it may not be possible to monitor changes in population size in the near term, but efforts should be made to increase the ability to do so.

There was some discussion about whether each lake should be dealt with separately. It was unclear how individual lake targets would be established. There have been dams between them for a long time. One lake wasn't connected with the others historically. Hebb Lake was just a marsh prior to the dam. It is likely that it was a single population originally.

It was noted that there is little else that could be done to decrease direct mortality of Atlantic whitefish at present. However, Atlantic whitewfish, including adults, that fall over the Hebbville Dam are currently unable to return.

It was asked whether there should be separate targets for anadromous populations versus landlocked populations. Anadromy is absolutely important, but it must be facultative or Atlantic whitefish wouldn't persist in the 3 lakes. There was some discussion of how anadromy could be re-established in the Petite Rivière system with limited risk. It was suggested that a trap and truck method could be used at the base of the dams. This wouldn't require fish passage immediately, and it wouldn't increase the risk of allowing passage of invasive species. There may be benefits from having connectivity between lakes also.

There was some discussion of fish passage on Hebb Lake now. There is extensive work that needs to be done on the dams. Fish passage could be incorporated at that time. If there is a flux of young fish over the dam at the base of the lowermost lake that are effectively lost, they might be caught with a smolt wheel. However, a trap and lights were set up one year in the middle of the lake, but no young whitefish were caught.

It was suggested that examples of recovery targets developed by Parks Canada be examined. Some other land-based examples were presented, which tended to be more generic for data poor species but with specific numerical goals for species with information on historical abundance. The primary threats to these species are habitat related. The first list included many provincially red-listed species, a few of which are found in the Petite Rivière system. Examples from other marine and freshwater RPAs were also reviewed.

At the end of the discussion, it was agreed that an interim watershed specific abundance target above the mid-point of the range 550-2,000 mature individuals (e.g., above 1,275 mature individuals) should be proposed. It was agreed that this target would need to be revisited once knowledge about the dynamics of the recovering species is obtained. In addition, it was agreed that with only limited information about the past distribution of Atlantic whitefish, any watershed within Nova Scotia could be considered a potential candidate for Atlantic whitefish introduction, particularly watersheds lying within the bounds of their known former range.

Threats, Alternatives and Mitigation

A table of threats to Atlantic whitefish, alternatives and mitigation was reviewed for inclusion in the Science Advisory Report. It was felt that the table should indicate whether the identified threats were current or potential threats. Relative rank effect was not found to be useful for describing potential threats. It was agreed that the most pressing threats would be described in the text of the RPA.

There was some discussion of the mitigative nature of the intake screen on the Bridgewater municipal water intake. It was thought to be small enough to prevent entrainment of larvae.

There was also some discussion of options for management of smallmouth bass. It was suggested that there could be targeted removals during spawning season through electrofishing.

Other Considerations

It was noted that DFO would be unlikely to proceed with increasing fish passage on the existing lakes unless it was determined that the risk to Atlantic whitefish was low.

A question was asked about what had been done in terms of Aboriginal consultations. There had been some discussions with Acadia First Nation because of their awareness of the species and there is more recent local Aboriginal representation on the Recovery Team from the Native Council of Nova Scotia, but nothing beyond that. Parks Canada could help to facilitate these discussions.

NEXT STEPS

In terms of next steps, it was stated that the Science Advisory Report would be revised based on the discussion of the meeting, circulated first to the assessment team and then circulated to participants for comment. Once comments had been received and incorporated as appropriate, an editorial meeting would be held and the Science Advisory Report (SAR) would be published to the Canadian Science Advisory Secretariat (CSAS) website. The proceedings of the meeting would be completed at some future date and circulated to participants prior to publication.

It was agreed that the 2 working papers were to be converted into Research Document as soon as possible. Reviewers and other participants were asked to provide any additional comments on these documents to Rod Bradford, copied to Tana Worcester.

REFERENCES

DFO. 2004. Proceedings of a Workshop on a Decision Support Tool for Stocking for Atlantic Whitefish; 24 November 2004. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2004/044.

DFO. 2009. Recovery Potential Assessment for Atlantic Whitefish (*Coregonus huntsmani*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/051.

Edge, T.A. 1984. The Systematics, Distribution, Ecology and Zoogeography of the Endangered Acadian Whitefish, *Coregonus canadensis* Scott, 1967, in Nova Scotia, Canada. M. Sc. thesis, University of Ottawa, Ottawa.

Appendix 1. List of Participants

Participant	Affiliation
Anderson, Kim	DFO Maritimes / SWNS
Austin, Deborah	Parks Canada Atlantic Service Centre
Bentzen, Paul	Dalhousie University / Biology
Bowlby, Heather	DFO Maritimes / PED
Bradford, Rod	DFO Maritimes / PED
Campbell, Dollie	DFO Maritimes / PED
Clifford, Paul	Unama'ki Institute of Natural Resources (UINR)
Gibson, Jamie	DFO Maritimes / PED
Giorno, Jennifer	DFO Maritimes / OHSAR (Habitat Management)
Grandy, Robert	DFO Maritimes / P&E
Heggelin, Anthony	NS Fisheries & Aquaculture / Inland Fisheries
Hiltz, Tim	PBSC, Bridgewater
Larocque, Sarah	DFO Maritimes / FAM
Longard, Dave	DFO Maritimes / OHSAR (Habitat Management)
Noto, Ashley	NS Power Inc.
O'Neil, Shane	DFO Maritimes / PED
Perley, Neil	Maliseet Nation Conservation Council (MNCC)
Robichaud-LeBlanc, Kim	DFO Maritimes / OHSAR (SAR Office)
Worcester, Tana	DFO Maritimes / CSA

Appendix 2. Terms of Reference

Recovery Potential Assessment for Atlantic Whitefish

Regional Peer Review Meeting

Carlisle Room, Days Inn
20 Highfield Park Drive, Dartmouth, NS
Chair: Tana Worcester

24-25 March 2009

TERMS OF REFERENCE

Background

Atlantic whitefish (*Coregonus huntsmani*), an anadromous fish endemic to Nova Scotia, was designated as Endangered in April 1984 and was added to Schedule 1 of the *Species at Risk Act* (SARA) when it came into force in 2003. This species was reassessed in 2000 and its endangered status was confirmed at this time. COSEWIC typically reassesses species status every ten years, which means that Atlantic whitefish is expected to be reassessed again in 2010. This Recovery Potential Assessment is being conducted by DFO in preparation for the upcoming reassessment by COSEWIC, as well as to contribute to the ongoing recovery planning efforts.

Objectives

The overall objective of this meeting is to peer-review information relevant to the upcoming COSEWIC status reassessment of Atlantic whitefish, as well as to determine the potential for recovery of this species. Specifically, to the extent possible:

Status and Trends

1. Evaluate the **present status** of Atlantic whitefish's abundance, range, and number of populations.
2. Evaluate the **recent trajectory** for abundance, range, and number of populations.
3. Estimate the current **life-history parameters** for Atlantic whitefish (total mortality, natural mortality, fecundity, maturity, recruitment) or reasonable surrogates; and describe associated uncertainties for all parameters.

Habitat Characterization

4. Provide functional descriptions of the **properties of aquatic habitat** (DFO, 2007b) required by Atlantic whitefish for successful completion of all life-history stages.
5. Describe the **spatial extent of suitable habitat,** i.e., habitat that is likely to have these properties within the species' range.
6. Assess how the biological function that specific habitat features provide to Atlantic whitefish vary with the **state or amount of habitat**, including carrying capacity limits.
7. Provide advice on any tradeoffs (i.e., pros and cons) associated with habitat **allocation options**, if any options would be available at the time when specific areas are designated as Critical Habitat.

8. Assess the **degree to which the supply of suitable habitat meets the demands** of Atlantic whitefish at present.
9. Evaluate **residence requirements** for Atlantic whitefish, if any.

Threats

10. Quantify the magnitude of each of the major potential **sources of mortality** identified in the COSEWIC Status Report, from DFO sectors, and other sources.
11. Identify the activities most likely to result in **threats to the functional properties of habitat** of Atlantic whitefish, and provide information on the extent and consequences of these activities within its range. [Provide advice on the extent to which various threats can alter the quality and/or quantity of habitat that is available.]
12. Assess how activities identified in Step 11 have resulted in **reductions to habitat quantity and quality to date**, if at all.

Mitigation and Alternatives

13. Develop an inventory of all feasible **mitigation measures** that could be used to minimize the threats to Atlantic whitefish and its habitat.
14. Develop an inventory of all reasonable **alternatives** to activities that are threats to Atlantic whitefish and its habitat, but with potential for less impact.
15. Develop an inventory of **activities that could increase the productivity or survivorship** of Atlantic whitefish.
16. Provide advice on **feasibility of restoring habitat** to higher values, if supply may not meet demand by the time recovery targets would be reached.
17. Estimate the expected **impact on abundance and distribution** of Atlantic whitefish from identified mitigation measures, alternatives, restoration activities, and activities that may alter the productivity or survivorship of Atlantic whitefish.

Recovery Targets

18. Estimate expected abundance and distribution **targets for recovery**, according to DFO guidelines (DFO, 2005).

Assessment of Recovery Potential

19. **Given current population dynamics parameters** and associated uncertainties, project expected population trajectories over three generations (or other biologically reasonable time), and trajectories over time to the recovery target using DFO guidelines on long-term projections (Shelton et al., 2007).
20. **Given alternative mortality rates and productivities** associated with specific scenarios identified for exploration, project expected population trajectory (and uncertainties) over three generations (or other biologically reasonable time), and to the time of reaching recovery targets.
21. Assess the **probability that the recovery targets can be achieved** under current rates of population dynamics parameters, and how that probability would vary with different mortality (especially lower) and productivity (especially higher) parameters.
22. Assess the **degree to which supply of suitable habitat will meet the demand** of Atlantic whitefish when it reaches recovery targets for abundance, range and/or number of populations.

Outputs

- CSAS Science Advisory Report
- CSAS Proceedings of meeting
- CSAS Research Documents

Participation

- DFO Science
- DFO Fisheries and Aquaculture Management, Oceans and Habitat Management, Policy and Economics, and the SARA Coordination Office
- Aboriginal Communities
- Province of Nova Scotia
- External Reviewers
- Industry
- Non-governmental organizations
- Other Stakeholders

References

DFO. 2005. A Framework for Developing Science Advice on Recovery Targets for Aquatic Species in the Context of the *Species at Risk Act*. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2005/054.

DFO. 2007a. Revised Protocol for Conducting Recovery Potential Assessments. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/039.

DFO. 2007b. Documenting Habitat Use of Species at Risk and Quantifying Habitat Quality. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/038.

Shelton, P.A., B. Best, A. Cass, C. Cyr, D. Duplisea, J. Gibson, M. Hammill, S. Khwaja, M. Koops, K. Martin, B. O'Boyle, J. Rice, A. Sinclair, K. Smedbol, D. Swain, L. Velez-Espino, and C. Wood. 2007. Assessing Recovery Potential: Long-Term Projections and Their Implications for Socio-Economic Analysis. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/045.

Appendix 3. Agenda

Recovery Potential Assessment for Atlantic Whitefish
Maritimes Region Science Advisory Process

Carlisle Room, Days Inn
20 Highfield Park Drive, Dartmouth, NS
Chair: Tana Worcester

March 24-25, 2009

DRAFT AGENDA

24 March 2008 – Tuesday

9:00 – 9:30	Introduction (chair)
9:30 – 10:00	Presentation on Atlantic Whitefish Life History Parameters, Recent Status and Trends (R. Bradford)
10:00 – 10:45	Presentation on Habitat Characteristics (A. Cook & R. Bradford)
10:45 – 11:00	Break
11:00 – 12:00	Presentation and Discussion on Recovery Targets
12:00 – 1:00	Lunch (not provided)
1:00 – 2:00	Presentation on Threats (R. Bradford)
2:00 – 3:00	Presentation on Mitigation and Alternatives (R. Bradford)
3:00 – 3:30	Break
3:30 – 4:00	Presentation on Recovery Potential of Atlantic Whitefish
4:00 – 4:30	Research Recommendations

25 March 2008 – Wednesday

9:00 – 9:30	Review of Previous Day
9:30 – 10:30	Review of SAR
10:30 – 10:45	Break
10:45 – 12:00	Review of SAR
12:00 – 1:00	Lunch (not provided)
1:00 – end	Review of SAR (as required)